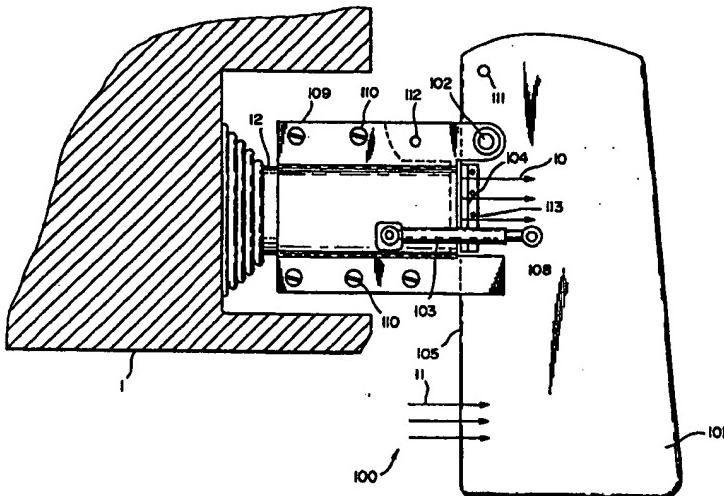




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(71) Applicant (for all designated States except US): WARING, Anne [US/US]; P.O. Box 10174, Bainbridge Island, WA 98110 (US).		Published With international search report.
(72) Inventor; and		
(75) Inventor/Applicant (for US only): NARTE, Henry, F. [US/US]; P.O. Box 11246, 9255 Miller Road, Bainbridge Island, WA 98110 (US).		
(74) Agents: MARQUARDT, Matthew, J. et al.; Garrison & Associates PS, Suite 3300, 2001 Sixth Avenue, Seattle, WA 98121 (US).		

(54) Title: RETRACTABLE RUDDER FOR JET SKI



(57) Abstract

A retracting rudder (101) for a jet ski (1) or other jet-propelled watercraft. The rudder is biased toward a deployed position in which it protrudes into or through the craft's jet propulsion stream (11), so as to provide improved turning performance when the jet is operated at a reduced power setting. As the operating power of the jet is increased, the force of the jet impinging on a pressure plate (104) provided at the leading edge (105) of the rudder causes the rudder to retract into a position away from the propulsion stream, clearing the jet to provide increased power while allowing the jet to assume an increased role in steering. A preferred embodiment of the invention comprises an auxiliary rudder pivotally attached to a jet nozzle (12) of a watercraft, a biasing or deploying means (13) adapted to bias the rudder toward a deployed position in which the rudder impinges upon a propulsion jet emanating from the nozzle, and preferably into the fluid stream beneath or alongside the ski as well, and a pressure plate attached to a leading edge of the rudder and adapted to at least partially obstruct said jet when the rudder is in the deployed position.

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Title:

RETRACTABLE RUDDER FOR JET SKI**TECHNICAL FIELD**

The invention relates to steering apparatus for jet-propelled watercraft. More
5 particularly, it relates to method and apparatus for a retractable auxiliary rudder for a jet ski.

BACKGROUND OF THE INVENTION

Small personal watercraft known as jet skis typically consist of a powerful floating
engine propelled by a water jet. In conventional designs, the water jet is capable of being
10 selectively directed through any of a range of angles with respect to the longitudinal axis of the
watercraft in order to provide steering control for the craft. At relatively high power settings,
when the jet is relatively strong, this works satisfactorily and the craft is more or less
maneuverable. At low power settings, however, the force of the jet is substantially diminished
and steering control is greatly reduced or even completely eliminated: there is simply no, or
15 insufficient, power available to change the craft's heading. In addition to constituting a
nuisance, the lack of steering control thus induced can be extremely dangerous, especially when
power is suddenly cut (or lost) when the craft is traveling at high speed or when the ski is being
maneuvered at low speed, as for example during docking procedures.

Several attempts have been made a providing auxiliary steering control for jet-powered
20 watercraft. For example, U.S. Patent No. 3,982,494 to Posti discloses an auxiliary rudder unit
for a jet propulsion unit. A complex mechanism comprising a hydraulic cylinder operated by
water pressure from a pump supplied by an external power source is coupled to rudder elements
to move the rudders to an inoperative position when the craft is driven at a sufficiently high
speed to power the pump. Thus deployment of the Posti device, and therefore the availability
25 of auxiliary steering control, is tied to vessel speed and not to jet power settings; so that when

power is suddenly cut or lost at high speeds, no auxiliary steering is available through the Posti rudder. Moreover, the Posti device is a relatively complex mechanism subject to a variety of mechanical failures. The Posti device would either have to be built into a watercraft during assembly of the craft itself, or retrofitted on a stock craft at the expense of extensive 5 modifications. It is not easily removable or installable.

U.S. Patent No. 3,976,026 to Eastling discloses a slow speed steering control for jet powered watercraft. The Eastling device is continuously deployed, however -- that is, it does not retract out of the fluid stream at high speeds or high power settings. Like the Posti device, the Eastling device could not easily be retrofitted to stock jet-steered craft, but would either have 10 to be built-in or require extensive modification efforts later. Moreover, because the Eastling device is permanently installed in a deployed position, retrofitting a stock jet-steered craft would result in serious oversteering at high speeds. The same difficulties arise with the marine jet drive with power trim control and auxiliary rudder steering disclosed in U.S. Patent No. 3,906,885 to Woodfill.

15 U.S. Patent No. 4,779,553 to Wildhaber, Sr., discloses an automatic rudder for outboard jet motors. An auxiliary rudder is pivotally mounted to fall under the force of gravity into a deployed position in which it protrudes into or through the propulsion jet stream, and retracts into a non-deployed position at high power setting or at high watercraft speeds. The Wildhaber design is dependent solely upon gravity for its downward deployment; thus when the water craft 20 is traveling at high speed and power is lost, the resistance of the fluid stream about the motor and the watercraft will tend to prevent the rudder from deploying, and the rudder must be oriented in an up-and-down vertical configuration in order to function at all. Moreover, when power is lost or cut off at high speed steering control will still be substantially lost, and the value of the rudder negated. The lack of a biasing means for urging the Wildhaber device into 25 a deployed position prevents the Wildhaber device from deploying when required. This could be especially detrimental at high speeds and low power settings.

Another difficulty of the Wildhaber device is the relative inefficiency of the rudder for 30 automatic retraction out of the jet stream. For retraction the rudder mechanism depends entirely upon impingement of the jet stream and free fluid stream around the craft upon the leading edge of the rudder. Yet the Wildhaber rudder is designed for minimum hydrodynamic drag, when

centered, so that the effect of the jet and fluid streams on retracting the rudder is actually minimized. Thus the rudder is designed to be as inefficient for automatic retraction as possible.

Thus there exists a need for increasing the safety and maneuverability for jet skis by providing a means for positive and appropriate levels of steering control for such craft while in motion, regardless of engine or jet power settings or conditions. There is a further need for an apparatus for accomplishing these objectives which is compatible with and easily installed as a retrofit upon standard jet skis, without requirements for major modifications. There is also a need for such an apparatus which is fully effective at all speeds and power settings, without either oversteering or understeering the craft.

10

DISCLOSURE OF THE INVENTION

Accordingly, it is an object of the invention to provide increased safety and maneuverability for jet skis by providing a means for positive and appropriate levels of steering control for such craft while in motion, regardless of engine or jet power settings or conditions. It is a further object of the invention to provide an apparatus for accomplishing these objectives which is compatible with and easily installed as a retrofit upon standard jet skis, without requirement for major modifications. It is a further object to provide an apparatus which is fully effective at all speeds and power settings, without either oversteering or understeering the craft.

These and such other objects of the invention as will become evident from the disclosure below are met by the invention disclosed herein. The invention is an automatically retracting auxiliary rudder for a jet ski or other jet-propelled watercraft, adapted to provide direct fluid-dynamic steering control when the jet is operating at low power, and to retract into a position in which it is non-functional or provides reduced steering effectiveness when the jet is operating at high power. The rudder is biased toward a deployed position in which it protrudes into or through the craft's jet propulsion stream, so as to provide improved turning performance when the jet is operated at a reduced power setting. As the operating power of the propulsive steering jet is increased, the force of the jet impinging on a pressure plate provided at the leading edge of the rudder causes the rudder to retract into a position away from the propulsion stream, clearing the jet to provide increased power while allowing the jet to assume an increased role in steering.

In one aspect the invention provides a rudder apparatus for a jet powered watercraft. The apparatus comprises an auxiliary steering rudder pivotally attached to the jet nozzle of the watercraft; a biasing or deploying means adapted to urge the rudder toward a deployed position in which the rudder impinges upon or protrudes through the propulsion jet emanating from the 5 nozzle, and preferably into the fluid stream beneath or alongside the ski as well; a pressure plate attached to a leading edge of the rudder and adapted to at least partially obstruct said jet or jet nozzle when the rudder is in the deployed position; and optionally at least one auxiliary support adapted to engage the rudder when the rudder is in the deployed position. As the flow rate of the jet is increased, the impinging force of the jet on the pressure plate tends to counteract the 10 deploying force applied to the rudder by the biasing means, and tends to cause the rudder to rotate toward a retracted position wherein protrusion of the rudder into or through the jet stream is reduced and the effectiveness of the rudder as a steering device is either reduced or eliminated entirely. When the jet stream is shut off, or operated at reduced power, the force of the biasing means acting on the rudder overpowers the impinging force of the jet stream and urges the 15 rudder back into the deployed position.

Preferred embodiments of the invention optionally further comprise a means for securing the rudder in a stored or undeployed position (i.e., the retracted position), so that the rudder does not protrude beneath the watercraft to as great an extent as when it is in the deployed position and damage to the rudder, the watercraft, and other objects, and injury to handlers, may be 20 reduced during handling and storage of the watercraft.

In certain situations it is advantageous to increase the relative tendency of the rudder to remain in the deployed position. To this end, it is sometimes advantageous to reduce the effect of the propulsive jet stream in counteracting the biasing means in urging the rudder into deployment. This is easily accomplished in such circumstances by making the pressure plate 25 removable and removing it from the leading edge of the rudder.

The rudder of the invention is of a size and shape suitable for steering the type of craft to which it is to be mounted and under the conditions contemplated herein. Within the limits of geometry imposed by the particular craft with which it is to be used, a great number of sizes and shapes will serve. The selection of a suitable rudder geometry will not trouble the designer 30 of ordinary skill in the design of rudder for such craft, once he or she has been armed with this disclosure. Typically the rudder is of a length sufficient to protrude, when the rudder is in the

deployed position, not only through the propulsive jet stream but into the free fluid stream beneath the watercraft as well, where its steering effectiveness may be increased by motion of the craft through the water.

In preferred embodiments of the invention the rudder is pivotally attached to the jet nozzle of the watercraft by means of a pin, hinge, or other rotary attachment provided on a mounting bracket or mount fitting. The mount fitting is adapted to be attached to the jet nozzle by any suitable means, preferably by such means that the rudder assembly may be easily removed when desired without need for permanently modifying or damaging the jet nozzle. Moreover, unlike the Wildhaber rudder discussed above, the rudder according to the invention 10 may be attached to the jet nozzle in any orientation, vertical, horizontal, or in between. One particularly satisfactory means for pivotally attaching the rudder to the jet nozzle is through providing a bracket or fitting adapted to clamp or embrace the jet nozzle by means of mating housing plates or portions secured to each other by screws or the like. Such a bracket may easily be installed on or removed from the jet nozzle without need for modifying the nozzle at 15 all, without causing damage to the nozzle, and may conveniently be provided with a pair of extensions on a side of the bracket opposite (across the jet nozzle) from the mounting pin sized to receive the leading edge of the rudder and provide additional lateral support for the rudder under load.

The biasing or deploying means may comprise any suitable mechanism or device for 20 urging the rudder into the deployed position under the conditions herein contemplated. Thus suitable devices include springs, elastic cords, hydraulic or pneumatic devices, or the like. The selection of suitable and sufficient means will not trouble the designer of ordinary skill in the relevant art once armed with the disclosure herein.

The pressure plate serves to enhance the impinging force of the propulsion jet on the 25 leading edge of the rudder by effectively increasing the thickness of the rudder. Thus the pressure plate is of any shape and form suitable for that purpose. Generally the pressure plate is sized and located to obstruct a substantial portion or all of the exit of the jet nozzle. In preferred embodiments, however, some substantial portion of the nozzle is left unobstructed, so that a corresponding proportion of the propulsive jet may still serve to propel the craft even 30 when the rudder is deployed. It is also acknowledged that obstruction of the entire nozzle may in some engine or jet configurations cause problems in engine operation associated with backup

of the jet flow. It has been found that pressure plates blocking between approximately 15% and 85% of the cross sectional area of the nozzle provide superior and satisfactory performance. As previously indicated, it has also been found to be advantageous in some circumstances to make the pressure plate removable.

5 It is also generally advantageous, in embodiments of the invention intended for use with jet skis and other watercraft adapted for routine removal from the water, to provide a means for selectively securing the rudder in a stored or undeployed position (i.e., the retracted position) so that the rudder does not protrude beneath the watercraft to as great an extent as when it is in the deployed position and damage to the rudder, the watercraft, and other objects, and injury to 10 handlers, may be reduced during handling and storage of the watercraft. One suitable means for accomplishing this is to provide a hole at the top of the rudder, a matching hole in the mounting or attachment structure which holds the rudder to the jet nozzle and aligns with the rudder hole when the rudder is in the retracted position, and a removable key or pin to pass through the holes and hold the rudder in the retracted position.

15

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side schematic view of a preferred embodiment of a retractable rudder apparatus according to the invention installed on a jet nozzle. The rudder is shown in a deployed position.

20 Figure 2 is a side schematic view of a preferred embodiment of a retractable rudder apparatus according to the invention installed on a jet nozzle. The rudder is shown in a retracted position.

25 Figure 3 is a rear schematic view of a preferred embodiment of a retractable rudder apparatus according to the invention installed on a jet nozzle. The rudder is shown in a deployed position.

Figure 4a is a rear view of a preferred embodiment of a rudder and pressure plate according to the invention. Figure 4b is a rear view of an alternative preferred embodiment of a rudder and pressure plate according to the invention.

30

BEST MODE OF CARRYING OUT THE INVENTION

Turning now to the drawings, the invention will be described in a preferred embodiment by reference to the numerals of the drawing figures wherein like numbers indicate like parts.

- Figure 1 is a side schematic view of a preferred embodiment of a retractable rudder apparatus according to the invention installed on a jet nozzle. The rudder is shown in a deployed position in which rudder 101 extends through the propulsive jet emanating from jet nozzle 12 (indicated by arrows 10) to beneath the bottom of watercraft 1 (partially depicted) and into the fluid stream beneath the craft (designated schematically by arrows 11). Watercraft 1 is propelled by means of the fluid jet. When no auxiliary rudder is attached and the fluid jet is operating at a sufficiently high power setting, watercraft 1 is steered by various controlled deflections of nozzle 12, which cause the jet to provide an eccentric force to the watercraft (that is, a force not directed parallel to or along the central longitudinal axis of the watercraft) and therefore to turn the craft in a selected direction. To improve low-power steering performance for the ski, rudder 101 is pivotally attached to nozzle 12 by means of pin or hinge 102 on 5 optionally removable fitting 109. Fitting 109 is adapted to clamp jet nozzle 12 by means of mating housing portions secured to each other by means of fasteners 110 and comprises provisions for pivotal mounting of the rudder to the nozzle, by means of pins, hinges, axles, or other rotation-permitting attachments. The use of screws, bolts, and other removable fasteners is particularly advantageous for securing the rudder apparatus to the nozzle, as the entire rudder 10 15 apparatus may thus be removed or installed at will. Fitting 109 is provided with a pair of extensions or auxiliary supports 108 on a side of the fitting opposite across the jet nozzle from mounting pin 102. The extensions are sized and spaced to receive leading edge 105 of the rudder between them, and to provide lateral support for the rudder when it is loaded laterally due to steering, etc.
- Rudder 10 is urged toward the deployed position shown in Figure 1 by biasing means 20 25 30 13, which may comprise a set of mechanical or hydraulic springs, or other suitable device. When the propulsion jet is operating at a relatively low power setting, the force of impingement of the jet on leading edge 105 of the rudder and/or pressure plate 104 is less than the biasing force provided by the biasing means, so that the rudder remains in the deployed position, with all or part of the jet impinging on and flowing around the upper portion of the rudder and with the lower portion of the rudder protruding into the fluid stream beneath the ski, thus permitting

steering of the ski in a relatively conventional fluid-dynamic or mechanical manner: deflections in the ski nozzle, selectively induced by the operator of the ski in the normal manner also cause deflection of the rudder, and therefore the creation of steering forces so long as the ski is moving through a fluid with sufficient way -- regardless of the power setting for the jet.

5 Rudder apparatus 100 further comprises pressure plate 104, attached to leading edge 105 of the rudder, which partially or completely blocks the fluid jet emanating from nozzle 12 when the rudder is in the deployed position. As the power setting of the jet is increased, the increased flow rate of the jet increases the force of the jet impinging on the pressure plate, counteracting the biasing force of biasing means 103 and causing the rudder to rotate into a retracted position
10 about pivot 102 as shown in Figure 2. As the rudder rotates into the retracted position its contribution to the steering force on the ski decreases, while the steering effect of the jet increases. Thus satisfactory but not overpowering steering control is continuously available to the ski, increasing maneuverability and safety.

15 Optional additional features include locking a locking means adapted to permit the rudder to be stored securely in the retracted position, in order to prevent damage to the rudder and injury to handlers during transportation and storage. In Figure 1 pin holes 111 and 112 are positioned such that they align when rudder 101 is in a retracted position and a pin (not shown) may be inserted to store the rudder in a conventional locking manner. Holes 111 and 112 are aligned in Figure 2, which depicts the rudder in the retracted position.

20 Figure 3 is a rear schematic view of a preferred embodiment of a retractable rudder apparatus according to the invention installed on a jet nozzle. The rudder is shown in a deployed position, with the leading edge of the rudder between auxiliary supports 108 at the lower end of removable mounting fitting 109. Pressure plate 107 completely obstructs end 13 of jet nozzle 12.

25 Optional preferred pressure plate configurations are shown in Figures 4a and 4b. In Figure 4a pressure plate 107 completely obstructs end 13 of jet nozzle 12, as in Figure 3, while in Figure 4b pressure plate 107' blocks only the central and upper portions of the nozzle, so that jet flow continues to emanate from the lower portion of the nozzle. Partial obstruction provides a relatively lower impingement force of the jet on the leading edge of the rudder, but provides
30 continued thrust at low power settings with the rudder fully deployed. The configuration of the pressure plate and the extent to which it obstructs the jet nozzle, and therefore the flow

emanating from the nozzle, will affect the amount of force required to be supplied by the biasing means. However, suitable combinations of pressure plate shape and biasing means strength are relatively simple matters well within the skill of one of ordinary skill in the design of jet propulsion systems and will not trouble the designer armed with the disclosure herein.

5 In some circumstances it may be advantageous to remove the pressure plate and operate the auxiliary rudder in a relatively more constantly deployed position -- for example, where additional steering control is desired under a broader range of operating conditions. In such circumstances the rudder may be made easily removable by using screws, bolts, or other removable fasteners for attachments 113 to attach the pressure plate to the leading edge of the
10 rudder.

Preferred rudders according to the invention are fabricated from strong, lightweight, damage- and corrosion resistant materials such as high strength polymers, steel, aluminum, fiberglass and the like. Parts and components for the apparatus herein described may be fabricated from any materials suitable to accomplish the purposes described.

15 With regard to systems and components above referred to, but not otherwise specified or described in detail herein, the workings and specifications of such systems and components and the manner in which they may be made or assembled or used, both cooperatively with each other and with the other elements of the invention described herein to effect the purposes herein disclosed, are all believed to be well within the knowledge of those skilled in the art. No
20 concerted attempt to repeat here what is generally known to the artisan has therefore been made.

INDUSTRIAL APPLICABILITY

The invention has applicability to steering apparatus for jet-propelled and jet-steered watercraft. The invention represents apparatus for improving the steering qualities of such craft
25 when they are operated at reduced power settings, and therefore provides improved performance and safety for such craft.

In compliance with the statute, the invention has been described in language more or less
30 specific as to structural features. It is to be understood, however, that the invention is not limited to the specific features shown, since the means and construction shown comprise

preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims, appropriately interpreted in accordance with the doctrine of equivalents.

CLAIMS

I claim:

5

1. A retractable rudder apparatus for a jet powered watercraft, the apparatus comprising:
a rudder pivotally attached to a jet nozzle of a watercraft;
a biasing means adapted to bias the rudder toward a deployed position in which the
rudder impinges upon a jet emanating from the nozzle;
10 a removable pressure plate attached to a leading edge of the rudder and adapted to at
least partially obstruct said jet when the rudder is in the deployed position; and
at least one auxiliary support adapted to engage the rudder when the rudder is in the
deployed position, said support disposed opposite said pivot, with respect to the jet;
whereby, as a flow rate of said jet is increased an impinging force of the jet on the
15 pressure plate tends to counteract a deploying force applied to the rudder by said biasing means
and tends to cause the rudder to rotate toward a retracted position wherein protrusion of the
rudder through said jet is reduced.

2. A retractable rudder apparatus for a jet powered watercraft, the apparatus comprising:
20 a rudder pivotally attached to a jet nozzle of a watercraft;
a biasing means adapted to bias the rudder toward a deployed position in which the
rudder impinges upon a jet emanating from the nozzle;
a pressure plate attached to the rudder and adapted to at least partially obstruct said jet
when the rudder is in the deployed position;
25 whereby, as a flow rate of said jet is increased an impinging force of the jet on the
pressure plate tends to counteract a deploying force applied to the rudder by said biasing means
and tends to cause the rudder to rotate toward a retracted position wherein protrusion of the
rudder through said jet is reduced.

3. The apparatus of Claim 2, further comprising at least one auxiliary support adapted to engage the rudder when the rudder is in the deployed position, said support disposed opposite said pivot with respect to the jet.
- 5 4. The apparatus of Claim 2, further comprising means for securing the rudder in a stored position wherein damage to said rudder may be reduced during handling of the watercraft.
5. The apparatus of Claim 2, wherein said pressure plate is removable.

-1/4-

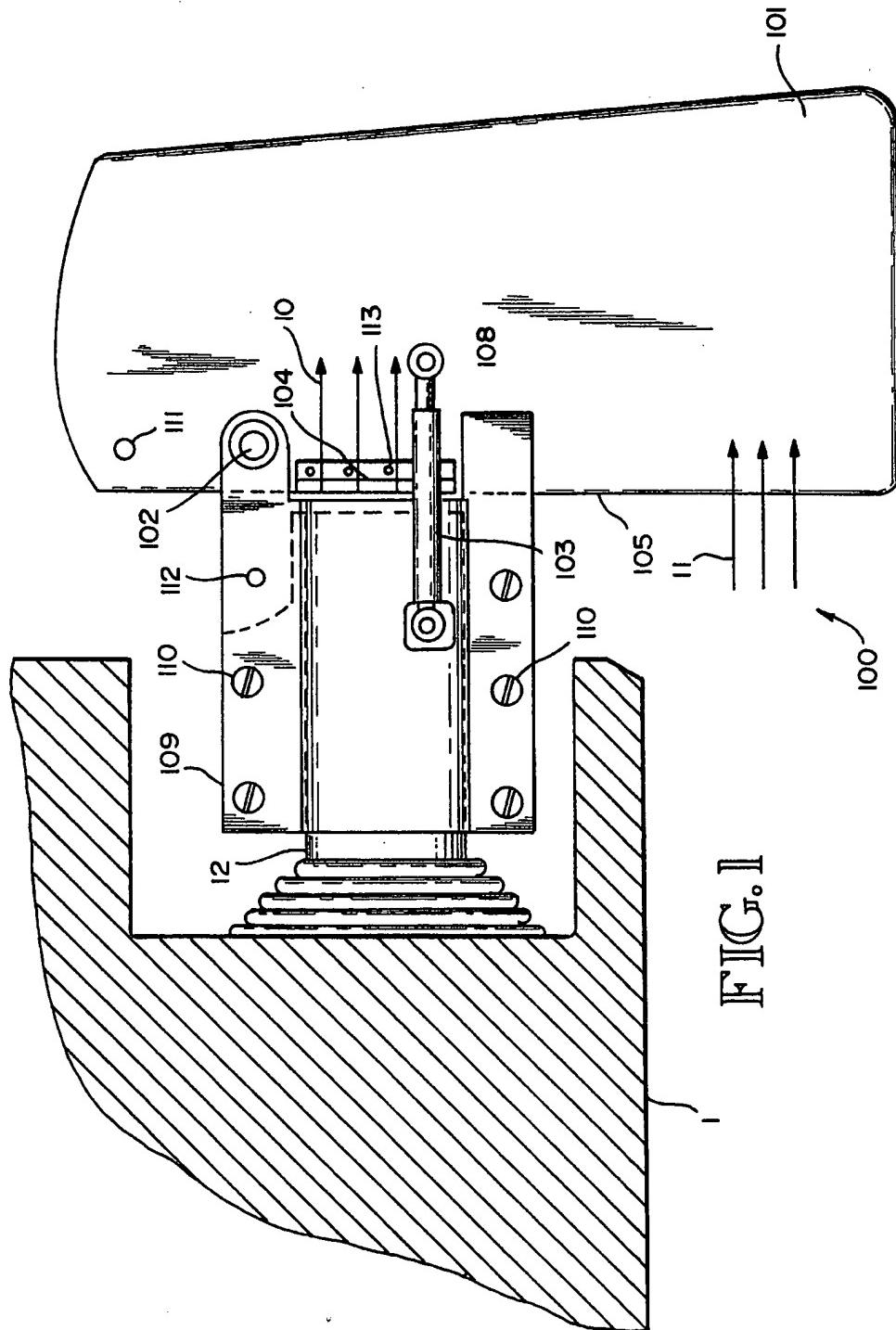
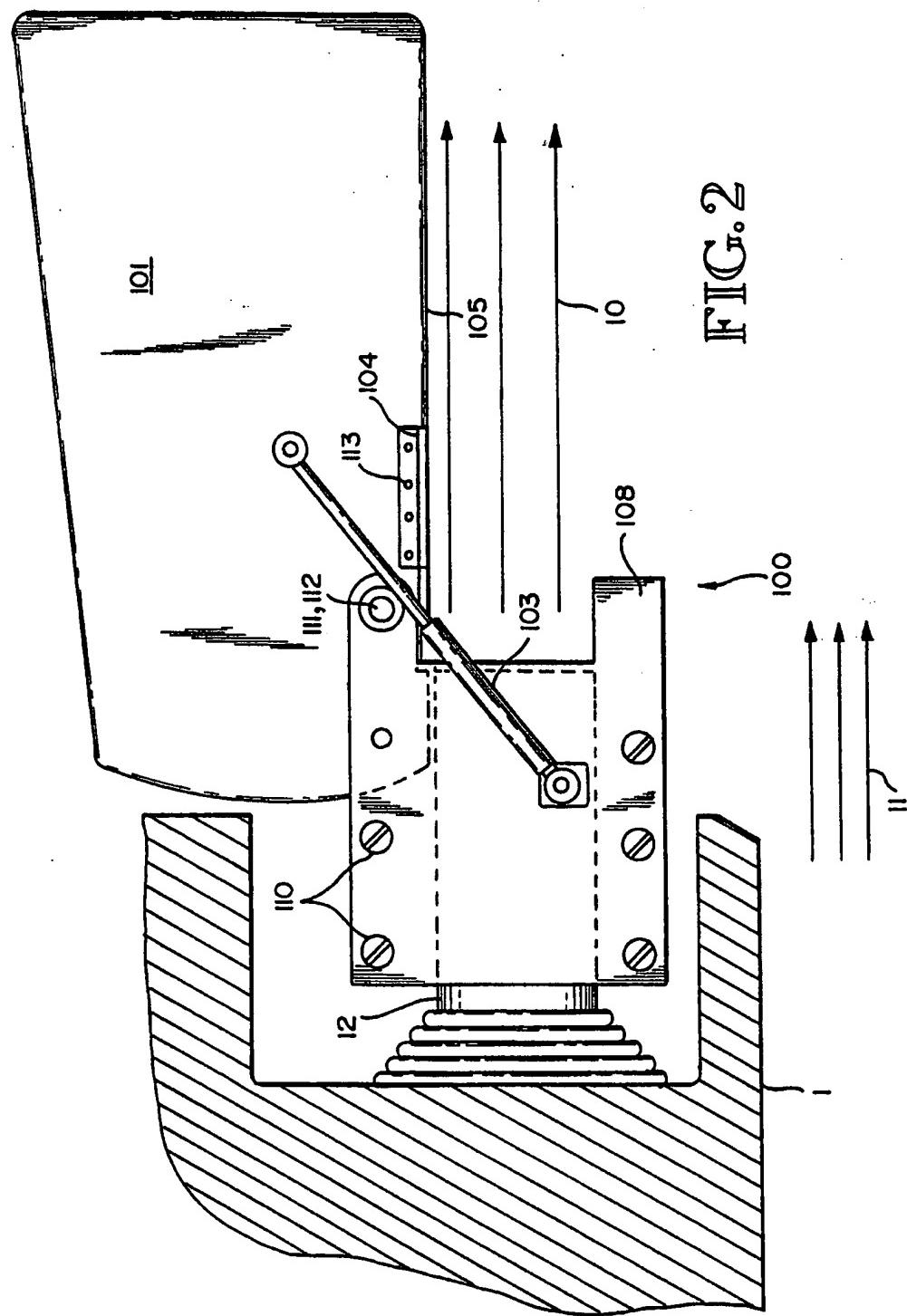


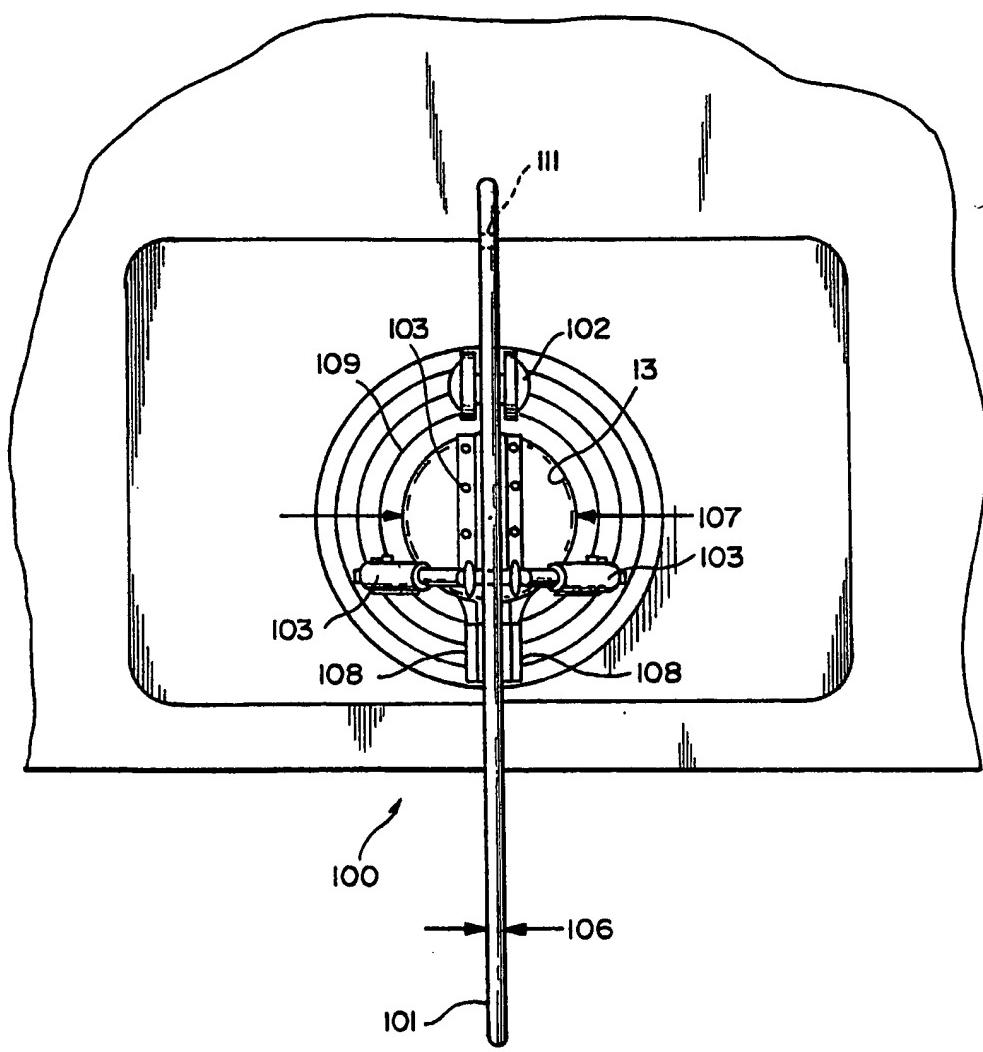
FIG. 1

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-3/4-

FIG.3



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FIG. 4B

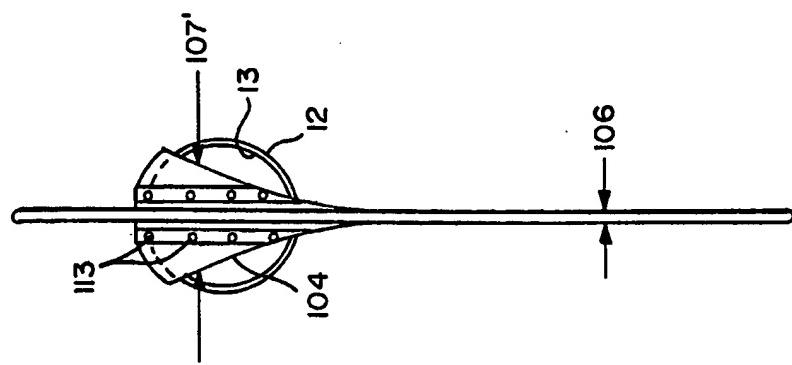
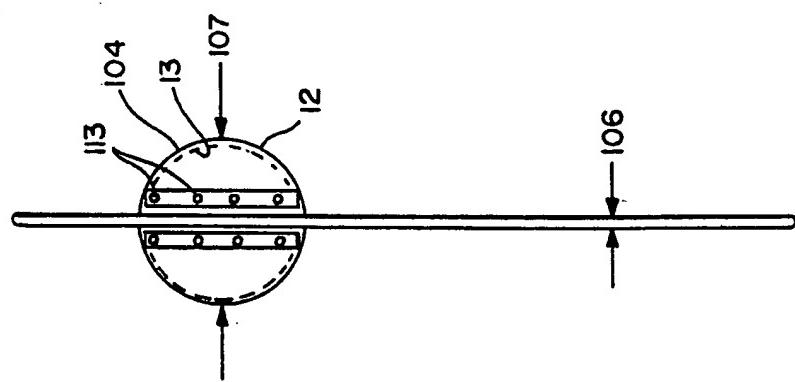


FIG. 4A



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/00041

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B63H 11/107
US CL : 440/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 440/40, 43; 114/150, 151

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

BRS

search terms: rudder, hinge, pivot

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 405162689 A (FUNABASHI) 29 JUNE 1993 (29.06.93) entire document.	1-5
Y	JP 0283593 A (KOBAYASHI) 21 NOVEMBER 1990 (21.11.90) entire document.	1-5
Y	US 4,779,553 A (WILDHABER, SR) 25 OCTOBER 1988 (25.10.88) figures 1-5.	1, 5
Y	US 4,319,538 A (MACFARLANE) 16 MARCH 1982 (16.03.82) abstract.	4

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search
16 MARCH 2000

Date of mailing of the international search report
17 APR 2000

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Authorized officer
S. JOE MORANO <i>Diane Smith Jr</i> Telephone No. (703) 308-0230